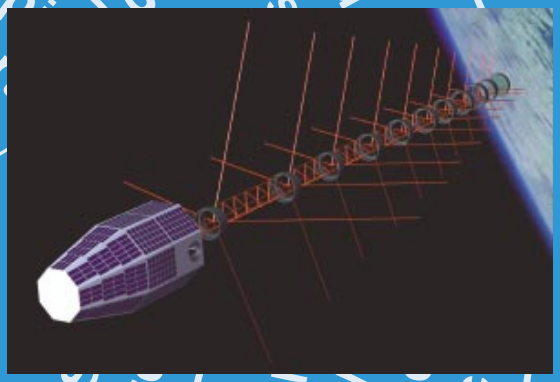
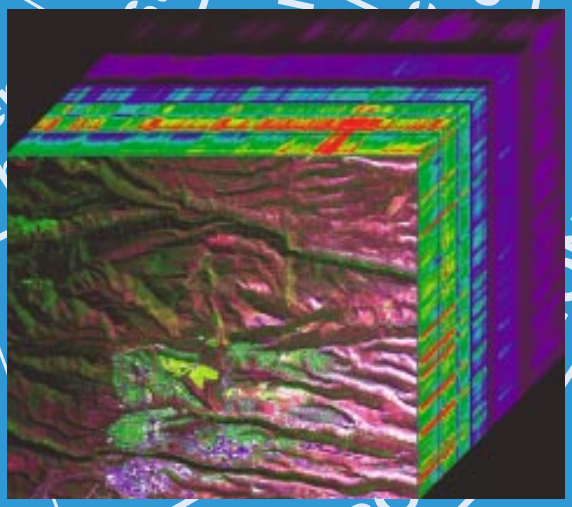
Nonproliferation and International Security
1996





A US Department of Energy Laboratory

Los Alamos
NATIONAL LABORATORY

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Cover Illustrations:

Clockwise from upper left: 1. An NIS-5 staff member (second from left) demonstrates the detection of nuclear material held up in a piece of equipment to students in a safeguards training course. 2. A potential proliferant ballistic missile system capable of delivering nuclear, chemical, or biological weapons. 3. Artist's conception of the FORTÉ satellite designed to improve the ability of the U.S. to detect clandestine atmospheric nuclear tests by measuring nuclear-generated electromagnetic pulses. 4. Hyperspectral image cube (with 224 spectral channels) from AVIRIS measurement over Los Alamos. Front image is in near infrared at 870 nm. Data were acquired from an altitude of 20 km.

LALP-96-20

April 1996

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The proliferation of weapons of mass destruction and the means to deliver them remain major national security issues despite the end of the Cold War. In the fall of 1993 the Nonproliferation and International Security (NIS) Program Office and Division were established at Los Alamos National Laboratory to respond to the proliferation threat. Our mission—to develop and apply preeminent science and technology to deter, detect, and respond to proliferation and to ensure U.S. and global security—challenges our very best scientists and engineers to seek innovative solutions to highly complex technical problems. Because we are science-based, we work with many researchers in universities and other laboratories in the U.S. and around the world. We work especially closely with our colleagues at Sandia and Lawrence Livermore National Laboratories. This tri-lab relationship has helped to make the Department of Energy's program in Nonproliferation and International Security highly efficient and productive. The dedicated men and women of NIS are proud to play a major role in reducing the global nuclear danger.

We hope you will take the time to browse through this brochure and get to know us better. If I can be of assistance or answer questions, please call me:

Donald Cobb, Director NIS,
(505-667-1212)
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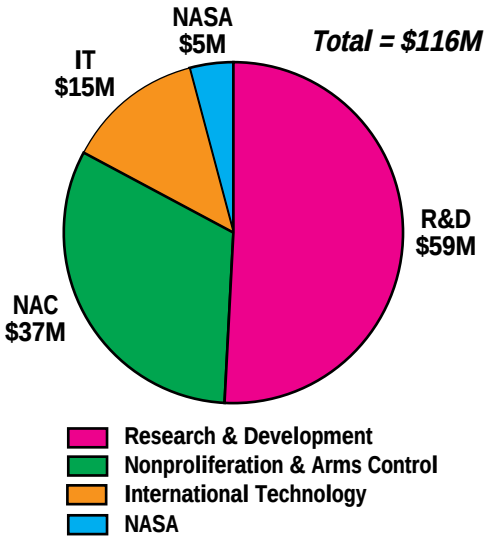
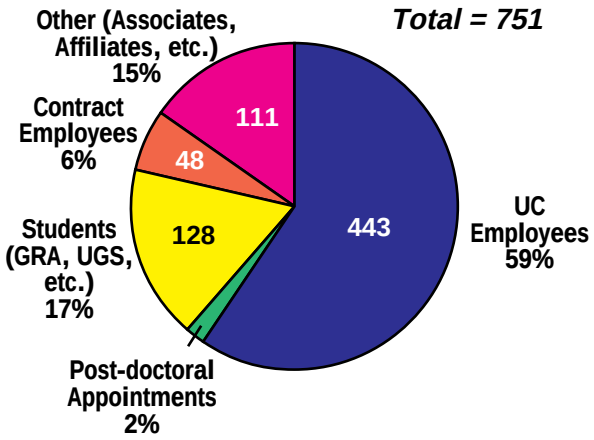
Los Alamos
NATIONAL LABORATORY

Nonproliferation and International Security Division Profile

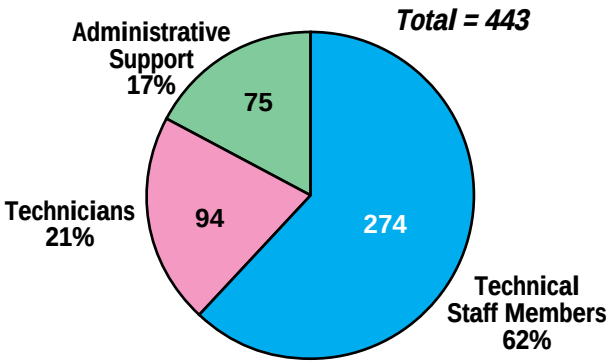
FY95 NIS Program Funding



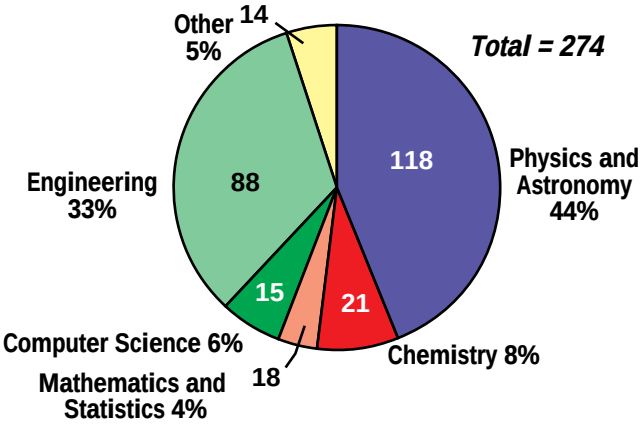
NIS Employee Demographics



NIS UC Employees



NIS Technical Staff Profile



Nonproliferation and International Security (NIS)

Laboratory Mission

The Los Alamos National Laboratory, which has provided over 50 years of service to the nation and played a major role in ending the Cold War, is recognized as one of the premier scientific and technical organizations in the world. Los Alamos attained this position of eminence for two reasons: it had a compelling mission (enabling nuclear deterrence), and it accomplished this mission by doing great science. Despite the end of the Cold War, Los Alamos still has a compelling core mission—reducing the global nuclear danger. We are accomplishing this mission by using the eight core competencies developed over our 50-plus-year history (shown as the center ring in the adjacent diagram). These core competencies provide us with the capabilities needed to address many other problems of national importance, including those shown in the outer ring of the diagram. Conversely, addressing problems in the outer ring of the diagram, such as attacking the major environmental issues facing our nation and the world, strengthens our core competencies and makes us better able to accomplish our core mission.

NIS Vision

The vision of the Nonproliferation and International Security Program and Division (NIS) is a world with reduced nuclear dangers as well as other threats to U.S. and international security through excellence in science and technology.

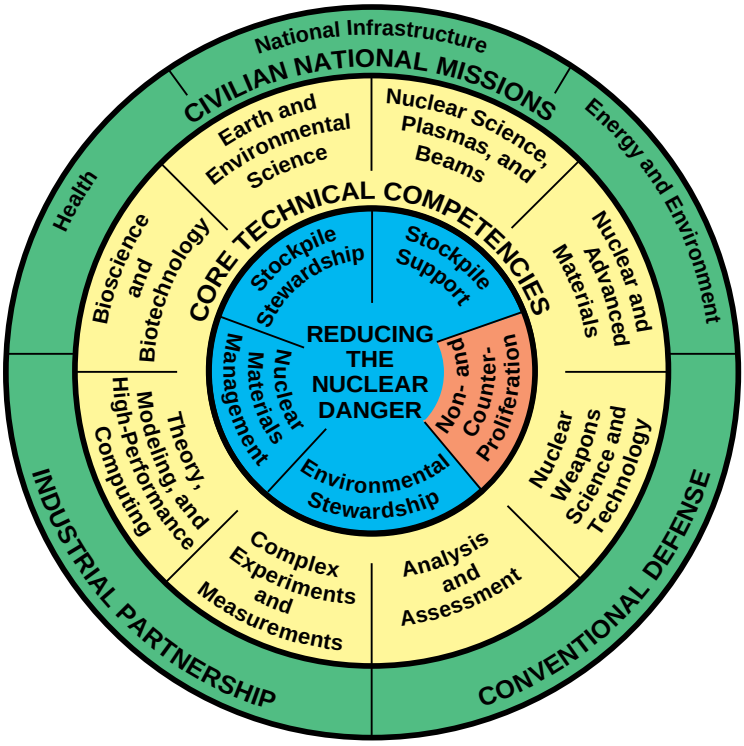
NIS Mission

Our mission is to develop and apply preeminent science and technology capabilities to deter, detect, and respond to proliferation of weapons of mass destruction and to ensure U.S. and international security.

NIS Objectives

We are pursuing five strategic objectives to accomplish our mission and thereby realize our vision:

- Deter threats to domestic and international security.
- Detect and assess threats to domestic and international security.
- Respond to domestic and international security threats.



Applying great science to accomplish the central mission of Los Alamos (reducing the nuclear danger) allows us to contribute to the solutions of other global challenges.

- Excel in science and technology.
- Ensure an environment that nurtures, supports, and rewards people working to accomplish our challenging mission.

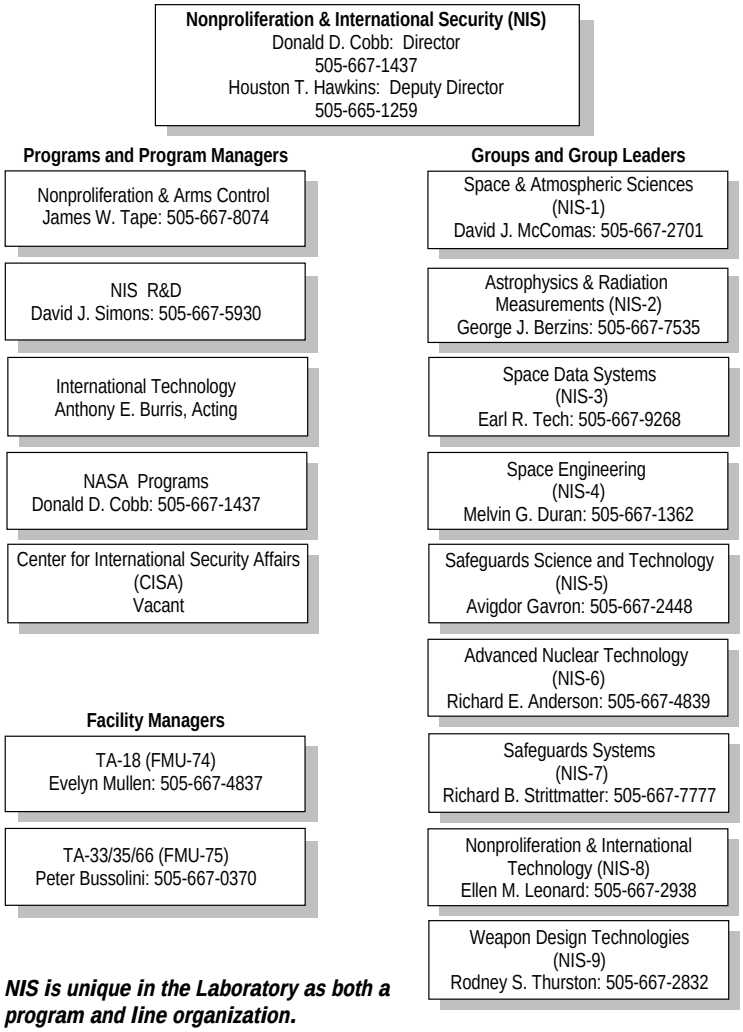
Program Focus Areas

NIS has Laboratory-wide responsibility for four principal focus areas: nonproliferation and arms control (NIS/NAC); technology research and development (NIS/RD); international technology (NIS/IT); and NASA research programs. The first three of these areas are described in detail in subsequent pages.

NIS is a major participant in NASA's space research program. NIS scientists publish regularly in such journals as the *Journal of Geophysical Research—Space Physics*, *Geophysical Research Letters*, and the *Astrophysical Journal*. Some of the most significant of our recent publications describe discoveries of new phenomena in the high-latitude heliosphere by Los Alamos plasma instruments onboard the Ulysses spacecraft.

Center for International Security Affairs (CISA)

This center, established in 1995, coordinates the growing interactions between the Laboratory and the countries of the former Soviet Union, China, and other countries.



NIS is unique in the Laboratory as both a program and line organization.

Organization

NIS is unique at Los Alamos as both a program office and line division. As shown in the adjacent chart, three Program Managers support the NIS Program Director, Donald D. Cobb, in managing the Nonproliferation and International Security Program, which accounted for 10% of the Laboratory budget in FY95. Nine groups provide the personnel and technical resources to implement this program. NIS program responsibilities are Laboratory-wide. NIS Division supports several other Laboratory programs; however, in FY95, 76% of the NIS program funds were expended in NIS Division and 73% of the Division's funding came from the NIS program. NIS carries on a vigorous program of scientific research. As the accompanying chart illustrates, NIS contributes to all the core competencies of the Laboratory. In 1995, we helped train 194 students, including 22 post-doctoral researchers, and published 183 papers in peer-reviewed scientific journals.

Special Services

NIS Division maintains the Laboratory's sensitive compartmented information (SCI) facilities and is the focal point for all support to the Intelligence Community. NIS acquires, organizes, and accesses intelligence information for Laboratory national security programs.

NIS contributes to all of the core competencies of the Laboratory.

Laboratory Core Competency	NIS-1	NIS-2	NIS-3	NIS-4	NIS-5	NIS-6	NIS-7	NIS-8	NIS-9
1. Theory, Modeling, and High-Performance Computing	✔	✔	✔	✔	✔	✔	✔	✔	✔
2. Complex Experimentation and Measurement	✔	✔	✔	✔	✔	✔	✔	✔	✔
3. Nuclear and Advanced Materials					✔	✔	✔	✔	✔
4. Nuclear Weapons Science and Technology	✔	✔		✔	✔			✔	✔
5. Analysis and Assessment	✔	✔		✔	✔	✔	✔	✔	✔
6. Earth and Environmental Systems	✔	✔	✔	✔	✔				
7. Bioscience and Biotechnology									✔
8. Nuclear Science, Plasmas, and Beams	✔	✔	✔	✔	✔	✔	✔	✔	✔

Nonproliferation and Arms Control (NIS/NAC)

Program Manager: James W. Tape
Phone: 505-667-8074

NIS supports the U.S. national policy by making nonproliferation technologies and technical support available to members of a national and international community that includes not only DOE but also DoD, the Department of State, the Arms Control and Disarmament Agency, Nuclear Regulatory Commission, other countries, and the International Atomic Energy Agency (IAEA). Nonproliferation technologies facilitate worldwide control of critical weapons design and development information, facilitate the control of technologies of proliferation concern, maintain treaties and agreements, and provide accurate indications, warnings, and assessments of activities indicating a possible diversion of SNM from acceptable commercial uses to military applications.

Controlling special nuclear materials (SNM) is one of only a few remaining effective barriers to nuclear proliferation, and controlling nuclear materials on a global basis is a NIS strategic initiative.

Dealing with the plutonium legacy of the past five decades is one of the Laboratory's six programmatic tactical goals. Prompt action is needed to deal with plutonium from dismantled weapons—particularly those in the former Soviet Union—and plutonium produced in commercial nuclear power reactors is becoming a source of major proliferation concern.

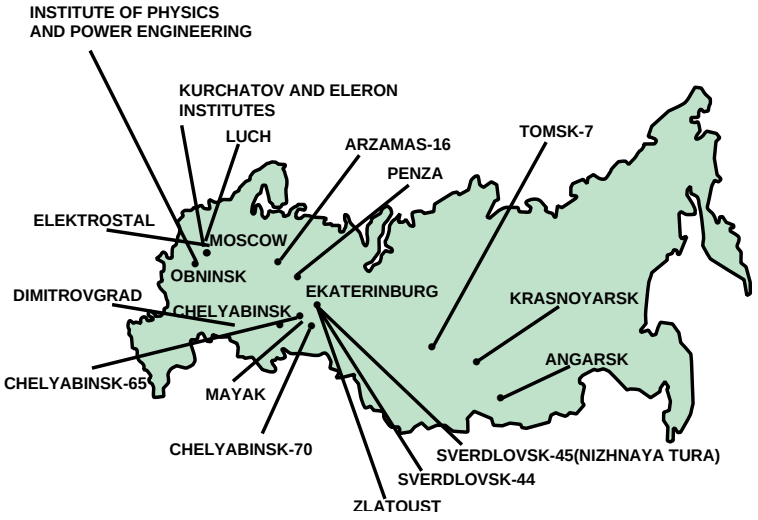
NIS conducts significant technology and technical support programs in support of the objectives of DOE's Office of Arms Control and Nonproliferation (NN-40) and Security Affairs (NN-50) in the areas of

- Analytical Support,
- Treaty Implementation,
- International Safeguards,
- Export Control,
- Nuclear Nonproliferation Policy Analysis, and
- Safeguards and Security Research and Development.

Program objectives are to

- support development and implementation of U.S. national security and foreign policies related to arms control and nonproliferation;
- execute a program of work in support of treaties, agreements, pertinent National Security Directives, and Presidential Decision Directives;
- enhance the effectiveness of international, regional, bilateral, and domestic safeguards and physical protection of nuclear materials; and
- control the export of nuclear-weapons-related equipment, materials, and technologies.

Los Alamos is leading an effort to upgrade nuclear materials protection, control, and accounting (MPC&A) technology in Russia. This initiative is rapidly deploying MPC&A technology to get Russian nuclear weapons materials under safe and secure storage. This is part of a major U.S. effort to work jointly with Russia and other states of the former Soviet Union to control nuclear weapons, materials, and expertise. Scientific collaborations under the lab-to-lab agreements provide an efficient mechanism for cooperative work and complement the more formal government-to-government arrangements.



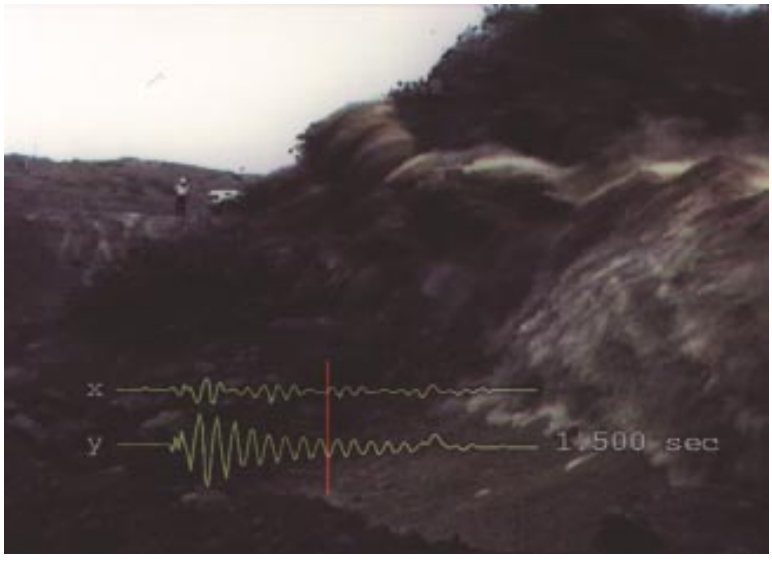
Los Alamos is working directly with Russian nuclear institutes to improve nuclear materials protection, control, and accounting (MPC&A) in the former Soviet Union.

Nonproliferation and Arms Control Research and Development (NIS/RD)

Program Manager: David J. Simons
Phone: 505-667-5930

NIS supports U.S. nonproliferation and security policies by developing sensors and analytical and modeling capabilities for detecting and characterizing proliferation, testing, and use of weapons of mass destruction and related materials, equipment, and processes (such as fissile materials production) and other activities inimical to domestic and international security. The Laboratory is developing remote sensing, monitoring, and assessment technologies for detecting and identifying emanations, effluents, and other distinctive signatures of potential nuclear weapons research and development efforts. Members of the defense community, including DOE, DoD, the Department of Justice, and the Intelligence Community, apply these technologies in both overt and covert configurations and in local, regional, and worldwide deployments.

Los Alamos is a leader in providing research and development to support our nation's nonproliferation program, and R&D to support proliferation detection is a NIS strategic initiative. This R&D includes identification and cataloging of signatures for proliferation activities and development of sensors capable of detecting and characterizing these signatures. Deployment platforms include space-, air-, sea-, and land-based configurations. On-going research and development projects such as CALIOPE (Chemical Analysis by Laser Interrogation of Proliferant Effluents), MTI (Multispectral Thermal Imaging), and RULLI (Remote Ultralow Light Level Imaging) are at the heart of this initiative.



NIS is developing technologies to verify the Comprehensive Test Ban Treaty.

NIS performs nonproliferation and treaty verification R&D for DOE's Office of Research and Development (NN-20), which sponsors the largest research and development program supporting U.S. national nonproliferation and arms control policy objectives. Principal task areas include

- On-Site Systems,
- Regional Monitoring Systems,
- Remote Sensing Systems, and
- Advanced Systems.

Among the technologies in the nonproliferation arsenal are effective remote-sensing and monitoring devices, low-cost satellites, and high-speed information networks. NIS encourages compliance with nuclear test ban treaties by developing and fielding treaty verification sensors and capabilities providing high confidence that any nuclear weapons test — regardless of whether it is conducted underground, in the atmosphere, or in space — will be observed and monitored.

Verifying compliance with a comprehensive ban on nuclear testing will require immense improvements to existing verification systems, and such R&D is another NIS strategic initiative. A comprehensive test ban (CTB) will be directed not only toward acknowledged nuclear weapons states but also toward those other nations and organizations with interests in developing a nuclear weapons capability. The Laboratory is directing efforts toward developing monitoring systems capable of detecting tests even at very low yields. Satellite-based systems continue to be the crucial element for monitoring tests in the atmosphere and in space. Follow-on systems to the existing GPS and DSP satellite systems, not currently programmed, must be developed to take advantage of modern sensor technology. Through such programs as FORTÉ (Fast, On-orbit Recording of Transient Events), emphasis is being placed on development of small, less expensive satellite systems. Underground tests must be detected by worldwide seismic, atmospheric, ionospheric, or hydroacoustic means, including some now under study in DOE's program.

International Technology (NIS/IT)

Program Manager: Anthony E. Burris, Acting
Phone: 505-667-4332

The problem of proliferation of weapons of mass destruction has been greatly intensified by increases in regional strife, growing world-wide inventories of special nuclear materials, the technical simplicity involved in producing and modifying biological and chemical agents, and the increased access to missile technology. The problem is further complicated by the specter of acts of terrorism by subnational groups employing weapons of mass destruction and of organized international criminals trafficking in nuclear materials and nuclear weapons components. A robust analytic program assessing foreign programs that could contribute to or be involved in the development and/or production of such weapons must be at the heart of an effective program to prevent proliferation of weapons of mass destruction. Assessments are made by technical experts who understand from first principles the technologies and processes involved while at the same time addressing nontraditional methods of acquiring the materials and expertise needed to realize the aims of the proliferant. NIS monitors foreign S&T developments to prevent damage to our national security by technological surprise. NIS has developed new methodologies for acquiring, cataloging, and analyzing the large volumes of data currently available and essential to a quality assessment. NIS develops tools employing state-of-the-art information management technologies to enhance the effectiveness of these experts and thereby achieve force multiplication in these times of constrained fiscal and personnel resources.

U.S. nonproliferation efforts are unlikely to be totally successful in deterring all nations from acquiring nuclear and other weapons of mass destruction and their means of delivery. NIS develops and provides a full spectrum of capabilities for responding to threats to domestic and international security including, when necessary, methods for mitigating and neutralizing these threats. Through DOE's Office of Energy Intelligence (NN-30) these capabilities are made available to senior policy-makers in DOE, DoD, the Intelligence Community, and national and local law enforcement agencies. NIS

- provides technical support in development of innovative options for mitigating new security threats, including those associated with the world-wide proliferation of advanced conventional weapons;
- provides technical and programmatic support to NEST and other emergency response activities within the Laboratory;
- develops advanced computational and analysis capabilities that provide rapid assessment of options for responding to evolving threats, including the capability to model the consequences of those response actions;
- develops a range of credible, high-confidence methods for locating, characterizing, and disabling nuclear, biological, and chemical weapons, including those of unknown design;
- develops technologies that provide battlefield commanders, military special forces teams, and law enforcement agencies with options short of the application of lethal force;
- provides real-time access to Laboratory resources and capabilities to support on-site reaction teams;
- develops creative technical solutions to "intractable" national security problems using the full range of expertise and competencies extant at the Laboratory; and
- provides the U.S. law enforcement community with access to appropriate Laboratory technical capabilities to counter criminal activities and terrorism.

NIS assesses foreign nuclear weapons programs and is applying enhanced information management-modeling-simulation techniques to the effort.

Center for International Security Affairs

The Center for International Security Affairs (CISA) at Los Alamos National Laboratory was created in January 1995 to coordinate LANL's growing interactions with the Newly Independent States, China, and other countries. CISA is responsible for all programs specifically created for work in these countries, including the Laboratory-to-Laboratory effort in nuclear materials control, our participation in the International Science and Technology Center, and the Los Alamos component of the Industrial Partnering Program. In addition, CISA oversees other programs to ensure that all Los Alamos activities abroad are consistent with U.S. objectives and policy.

Part of the nuclear material accounting system developed jointly by the Russian Federal Nuclear Center at Arzamas-16 and Los Alamos. Unauthorized movements of nuclear material represent the greatest near-term threat for the proliferation of nuclear weapons.

Our collaborations involve the scientific leaders of the Russian nuclear weapons program. This June 1992 photo shows Yuli Khariton (second from front on right), the chief designer of the first Russian atomic bomb, Yuri Trutnev (next to Khariton), chief designer of much of the Russian thermonuclear stockpile, and many other senior Russian weapons scientists. Today we are working together on problems of common interest including nuclear reactor safety, plasma physics, and the control of nuclear materials.

Weapons of mass destruction and especially nuclear weapons represent the only strategic threat to the United States. The principal objective of the programs coordinated by CISA is to actively reduce the threat of weapons of mass destruction through collaborative projects with colleagues overseas. In the Newly Independent States, the Center has the goal of stabilizing three major areas: nuclear materials, weapons expertise, and weapons institutions.

Nuclear material protection, control, and accounting (MPC&A) is by far the largest of the programs overseen by CISA. As the lead lab for this effort, Los Alamos works closely with other U.S. laboratories and our counterparts in Russia. Building on a foundation of trust and cooperation established through scientific collaboration between U.S. and Russian weapons laboratories since 1992, the U.S. Department of Energy in April 1994 initiated a new approach to MPC&A cooperation: the Lab-to-Lab MPC&A Program. Scientists and engineers at the laboratories, working under the guidance of their governments, plan and carry out the work. This approach has proved very productive and expeditious in highly technical fields such as MPC&A. Based on this new approach, rapid progress was achieved at Arzamas-16, the Kurchatov Institute, Chelyabinsk-70, and the Institute of Physics and Power Engineering at Obninsk.

Arzamas-16, one of two Russian nuclear weapon design laboratories, leads the effort for the Russians. The best of Russian and American MPC&A technologies and methods have been combined in an extensive demonstration facility that is paving the way for widespread implementation throughout the Russian nuclear weapons complex. Early in 1995, Arzamas-16 demonstrated its integrated MPC&A system to U.S. and Russian specialists. The system included stringent methods for entry control, nondestructive assay measurements, item control functions, and inventory verification. The U.S. provided equipment and technical support as its part of the collaboration, while the Russians provided Russian equipment and methods.

At the Kurchatov Institute, a leading designer of reactors, a basic MPC&A system was installed in one building where experiments with highly enriched uranium were conducted.

Director: Vacant
Phone: 505-667-0900

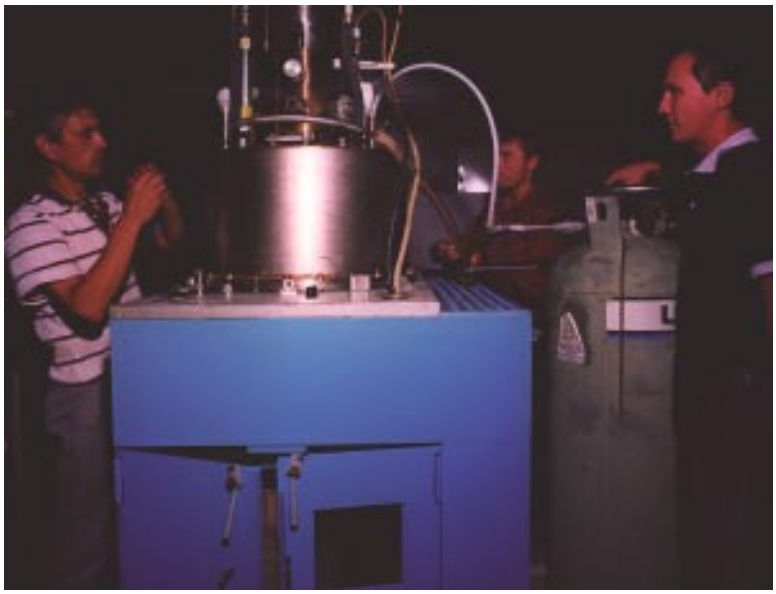
Deputy Director:
John Shaner

As a direct result of the U.S.-Russian collaboration, this building now has effective physical protection and computerized nuclear material accounting systems. One facility at the Institute for Physics and Power Engineering containing over three tons of special nuclear material was selected as the site for another MPC&A cooperative effort. A combination of U.S. and Russian technologies and methods was installed in 1995, including vehicle and pedestrian monitors to detect nuclear materials concealed in vehicles leaving the site or persons exiting the building.

Los Alamos also has extensive scientific interactions with Arzamas-16 and Chelyabinsk-70. For example, as of the Spring of 1996, we had conducted 18 major experiments in high-explosive pulsed power with Arzamas-16. These experiments combine a considerable Russian lead in high-energy pulsed power with advanced Los Alamos diagnostics to do science that neither side could do on its own. Scientists that were previously involved in the development of nuclear weapons are now working on problems of fundamental scientific interest: a process we call Scientific Conversion.

The Industrial Partnering Program is directed at the long-term stability of institutions that have been involved in weapons development. Its goal is to provide peaceful and profitable alternatives to weapons work through cooperative programs involving scientists and engineers in the Newly Independent States and in U.S. national labs and industry. Los Alamos participates in over two dozen projects with institutes in several of the Newly Independent States.

The Center for International Security Affairs has its own building at Technical Area 66 in Los Alamos. It has facilities for meetings of up to 60 people and can host foreign collaborators for extended periods. As the principal point of contact at Los Alamos for interactions in the Newly Independent States, China, and elsewhere, the Center can assist Laboratory personnel in establishing appropriate scientific projects and can provide the U.S. government and other organizations with information and advice on nuclear-related issues worldwide.



The Industrial Partnering Program provides long-term opportunities for scientists and engineers formerly involved in work on weapons of mass destruction. Here Russians, Ukranians, and Americans prepare an experiment on the microwave processing of materials.

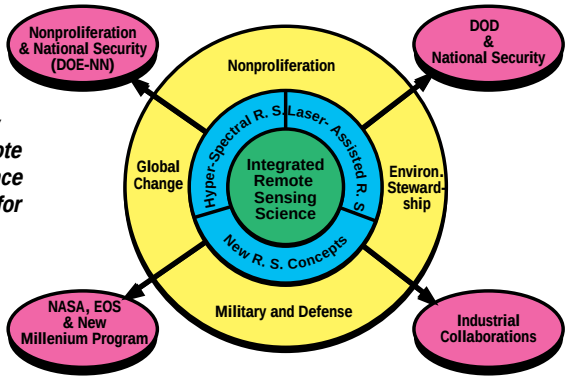
Our collaboration extends beyond pure science. Los Alamos and Arzamas-16 are sister cities with many nontechnical interactions including school pen-pal programs, teacher exchanges, and medical assistance. These efforts are funded by the Los Alamos community. Here a group of Russian colleagues examines a friendship book prepared by Los Alamos Middle School students.

Remote Sensing Science (RSS)– A Laboratory Thrust

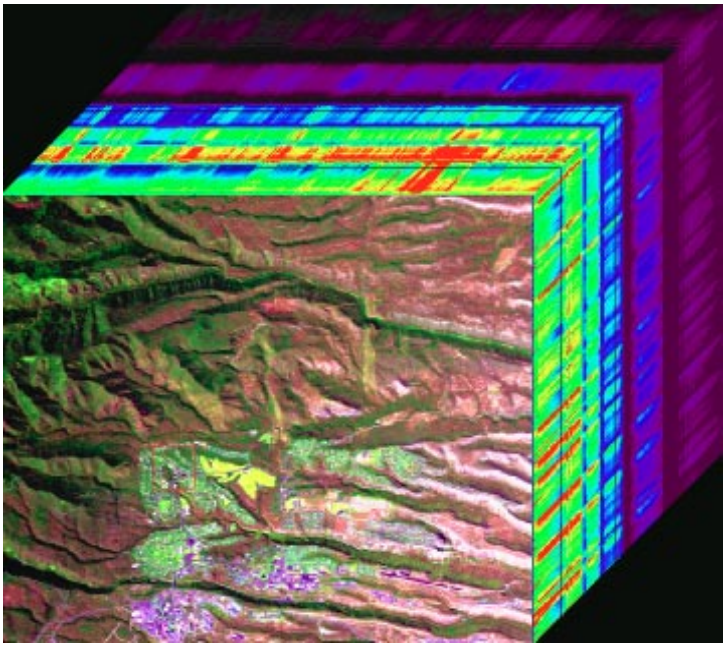
Remote Sensing Science
Principal Investigator: Sig A. Gerstl
Phone: 505-667-0952
Email: sig@lanl.gov

Revolutionary advances in our understanding of processes affecting the earth and its atmosphere will result from the emerging science of remote sensing. Los Alamos contributes to many phases of this scientific revolution. The Remote Sensing Science (RSS) Thrust pulls these efforts together in an integrated team.

Remote sensing instruments have been improving rapidly. Ground-based LIDAR instruments already provide time-resolved atmospheric aerosol images with sub-meter spatial resolution. The first space-based LIDAR recently flew on the Space Shuttle and species-specific LIDAR capabilities are evolving rapidly.



Strategic competency development for remote sensing (RS) as science and technology base for present and future customers.



Hyperspectral image cube (with 224 spectral channels) from AVIRIS measurement over Los Alamos. Front image is in near infrared near 870 nm. The yellow area is the town's golf course. Laboratory sites are in purple. Data were acquired from an altitude of 20 km.

New satellite instruments providing images with hundreds to thousands of visible and infrared spectral channels, which can reveal intricate details of the identity and state of observed substances, are being planned. Data from such capabilities require computational models at new levels of complexity and physical sophistication. Los Alamos is involved in these instrument technologies and model developments through its nonproliferation and environmental stewardship programs and is developing a strong core science foundation through the RSS Thrust.

The RSS Thrust builds on Los Alamos's strengths in visible and infrared spectral imaging and laser remote sensing (such as LIDAR) and our capability to develop new and innovative measurement and analysis techniques. We focus the thrust in three component areas: hyperspectral passive remote sensing, laser active remote sensing, and innovative new concepts. These components then feed an integrated approach to several "national laboratory class" research issues. These efforts build on a large programmatic investment in instrumentation, modeling, data analysis, and interpretation.

Specific key research areas for the integrated approach of this thrust include the characterization of gases emanating from volcanoes and understanding physical processes of atmospheric transport. Currently, vulcanologists use laboratory analysis of collected gas samples as the primary means of measuring the composition of volcanic plumes. These samples are difficult to collect, require long delays for analysis, and can at best provide data at a single point in space and time. Valuable new information about the dynamic processes occurring before, during, and after an eruption could be determined from the active and passive remotely sensed data from frequent measurements of the plume. Similarly, atmospheric scientists now rely on data collected by point sensors at fixed sites or on sondes. Lack of three dimensional, time-resolved data has limited understanding of physical processes involved in energy transport, moisture, and momentum, especially in the atmospheric boundary layer where turbulent mixing dominates. Results from the RSS Thrust are leading to a new understanding of the detailed physical mechanisms and larger scale behavior of the atmosphere.

Space and Atmospheric Sciences (NIS-1)

Group Leader: Dave McComas
Phone: 505-667-2701
Deputy Group Leader: Susan Voss

NIS-1 supports the DOE's mission to verify nuclear test ban treaties by developing technologies capable of detecting clandestine nuclear tests and by monitoring nuclear weapons proliferation activities. We are DOE's experts in nuclear weapons effects in the atmosphere and space, an expertise needed to support our treaty verification programs. NIS-1 has significant capability in designing, integrating, and analyzing data from space-based sensors.

NIS-1 monitors the atmosphere and near-earth space for possible nuclear tests with satellite-borne particle and radio-frequency detectors. The techniques under development to detect proliferation activities use neural networks, buried power line detection methods, krypton/xenon and tritium detectors, and neutron spectrometry. We also apply some of these techniques to the ground-based detection and characterization of nuclear materials for nonproliferation purposes.

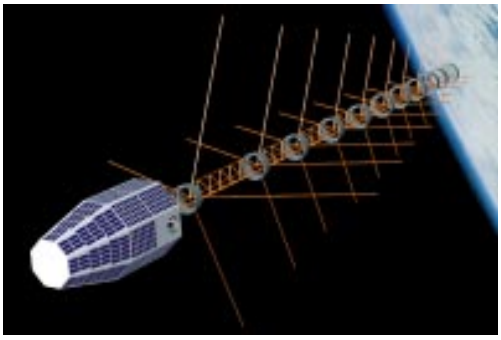
NIS-1 has built an international reputation by conducting scientific studies of the atmosphere, ionosphere, magnetosphere, and solar wind. Some of our current major programs in these areas are as follows:

- Plasma instruments for programmatic spacecraft at geosynchronous orbit, NASA/ESA Ulysses solar wind mission, and NASA's ACE solar wind mission
- Plasma and ion composition instruments for NASA/ESA Cassini mission to Saturn
- Blackbeard and FORTÉ satellites for direct measurements of trans-ionospheric propagation
- International collaborative studies of the natural and artificially disturbed ionosphere
- Neutron, gamma ray, and alpha-particle instruments for NASA's Lunar Prospector mission

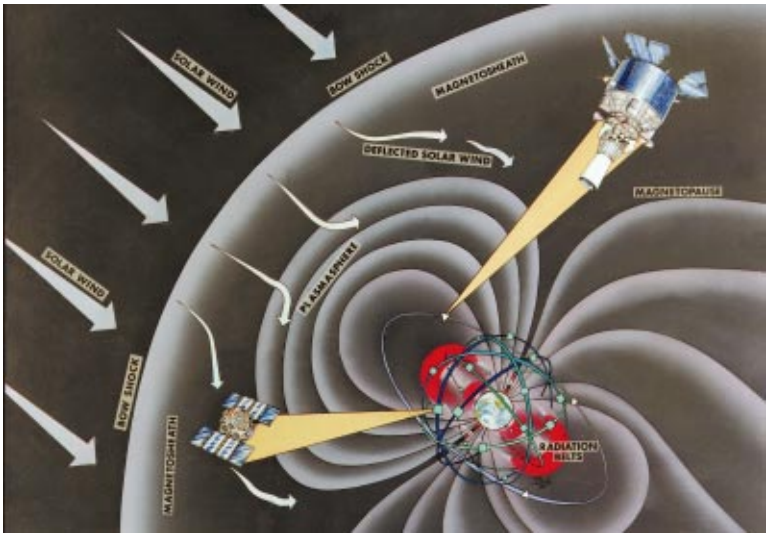
NIS-1 has a very broad range of capabilities that support our programmatic and scientific missions, including the following:

Radio and Ionospheric Physics - Detection and analysis of transient radio bursts using space-based and ground-based detection

- Lightning measurements and theory
- Detection of transient ionospheric pulse pairs



This is an artist's concept of the FORTÉ satellite that is being designed to improve the ability of the United States to detect clandestine atmospheric nuclear tests by measuring the nuclear-generated electromagnetic pulse from such a test.



CN84919

This artist's rendition of the magnetosphere shows the orbits of two satellite constellations that carry NIS-1 nuclear detection instruments to monitor the atmosphere and space for nuclear tests as well as to collect information on the near-earth space plasma environment.

- Trans-ionospheric and sub-ionospheric propagation studies
- 3-D ray-tracing models with integrated ionospheric models including the effect of the structured ionosphere
- Radio-frequency field experiments
- Ground-based electro-magnetic pulse generator for spacecraft calibration

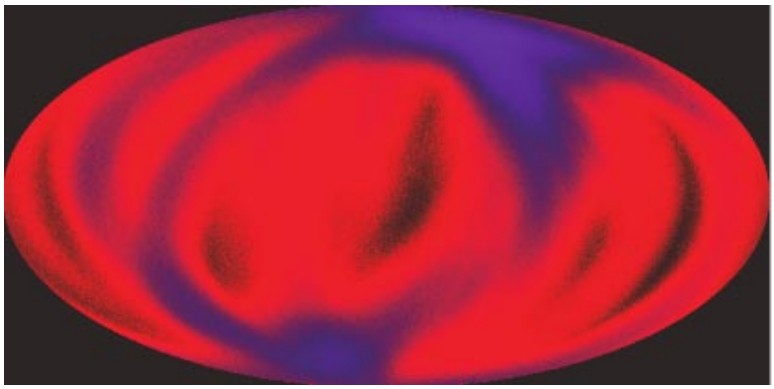
Space Physics - Instrumentation, analysis, and theory

- Space plasma physics
- Solar wind and solar-terrestrial physics
- Magnetospheric physics
- Planetary physics

Astrophysics and Radiation Measurements (NIS-2)

Group Leader: George J. Berzins
Phone: 505-667-7535
Deputy Group Leaders:
William J. Verzino and Paul G. Weber

The NIS-2 mission is to develop and apply remote sensing instrumentation to problems of national security and related basic science. Applications include nonproliferation, detection of nuclear explosions, climate studies, and environmental measurements, all coupled with strong contributions to the sciences.



Two years of ultra-soft X-ray data from the ALEXIS satellite were combined to form this map of the entire sky.

The DSP satellite, bearing Los Alamos treaty verification instrumentation, being released from the bay of the Space Shuttle.

Our specific capabilities include the following:

- Optical and infrared remote sensing on aircraft, on satellites, and on the ground in support of nonproliferation and environmental missions
- X-ray, gamma-ray, neutron, and energetic particle diagnostics in support of treaty verification and for scientific missions
- Small satellite systems design, operation, and related data analysis
- Astrophysics, including theory, modeling, instrumentation, and data analysis
- Planetary exploration missions using technologies related to our programmatic activities
- Magnetospheric physics missions for improved understanding of the solar/terrestrial system

NIS-2 has approximately 50 professional staff, including Laboratory technical staff members, contractors, post-doctoral fellows, and guest scientists as well as technical and administrative support personnel.

NIS-2 has a state-of-the-art optical and infrared calibration facility. We have several high-voltage pulsed x-ray sources, experimental vacuum chambers, several well-equipped instrumentation laboratories, and extensive computational equipment.

Our major customers are the DOE, National Aeronautics and Space Administration (NASA), Department of Defense (DoD), and other government agencies. We collaborate with universities, industry, and other research organizations.

Space Data Systems (NIS-3)

Group Leader: Earl R. Tech
Phone: 505-667-9268

Deputy Group Leader: Stephen G. Blair

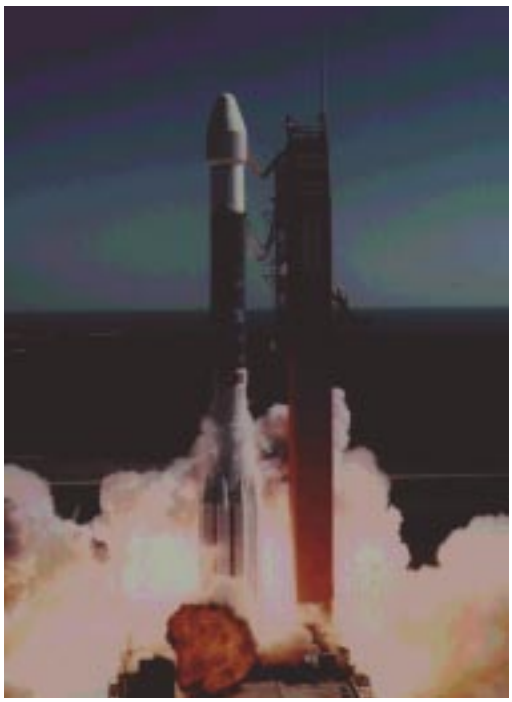
Group NIS-3 activities include developing real-time data acquisition and control systems, building and operating satellite ground stations, scientific and database programming, and maintaining multi-user open and secure distributed computing environments. These efforts date from the Vela series of spacecraft in the early 1960s through a number of current DOE, DoD, and NASA missions. NIS-3 emphasizes consistent handling of data during the various phases of each experiment's lifecycle and focuses on use of standards and commercial products, reuse of software, and development of CPU-independent systems.

NIS-3 provides services to other groups at the Laboratory and in NIS, in particular NIS-1, 2, 4, and the NIS Research and Development Technology Program Office as well as other organizations as follows:

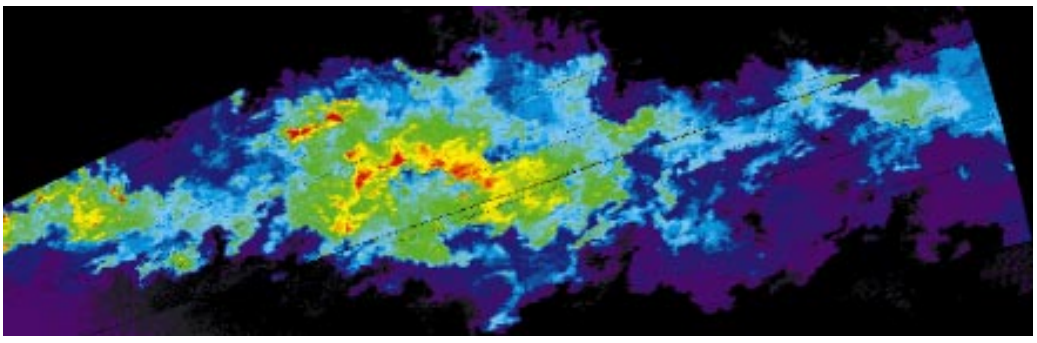
- Sandia National Laboratories (data handling and software development)
- United States Air Force, including Air Force Global Weather Central (space environmental data), Air Force Space Forecast Center (space environmental data), Air Force Space Command (satellite turn-on and early-orbit activities), and Air Force Technical Applications Center (analysis software)
- NASA Ames, Goddard, and Marshall facilities (data handling)
- European Space Agency (data exchange)

Following are some of NIS-3's areas of expertise and specific projects:

- Development of data acquisition systems, based on a standard architecture, for use with ground, air, and space-based scientific experiments (RADEC, GPS, MTI, CALIOPE, and CP-LIDAR)
- Management of all phases of software development for ground, air, and space-based instrumentation systems, including integration and test, flight, ground control, and scientific data analysis.
- Small satellite activities, including development of groundstations, integration and test, satellite operations, and development of flight software (ALEXIS and FORTÉ satellites)
- Development and operation of real-time data links and associated processing of on-orbit satellite data (RADEC and GPS)
- Support for a wide range of computer platforms, operating systems, programming languages, and tools in a heterogeneous distributed computing environment.



Launch of a GPS satellite aboard a Delta II rocket. NIS Division develops, builds, and analyzes data from several instruments on GPS spacecraft.



A LIDAR image of smoke from a forest fire, showing the distribution of suspended particles in the smoke plume. NIS-3 developed the data acquisition and control system and analysis software for the LIDAR system.

Space Engineering (NIS-4)

Group Leader: Mel Duran
Phone: 505-667-1362
Deputy Group Leader: Steve Wallin

NIS-4 is a design-to-completion science and engineering group that develops and produces sensors, instruments, and systems for applications requiring advanced monitoring, detection, and evaluation technology.

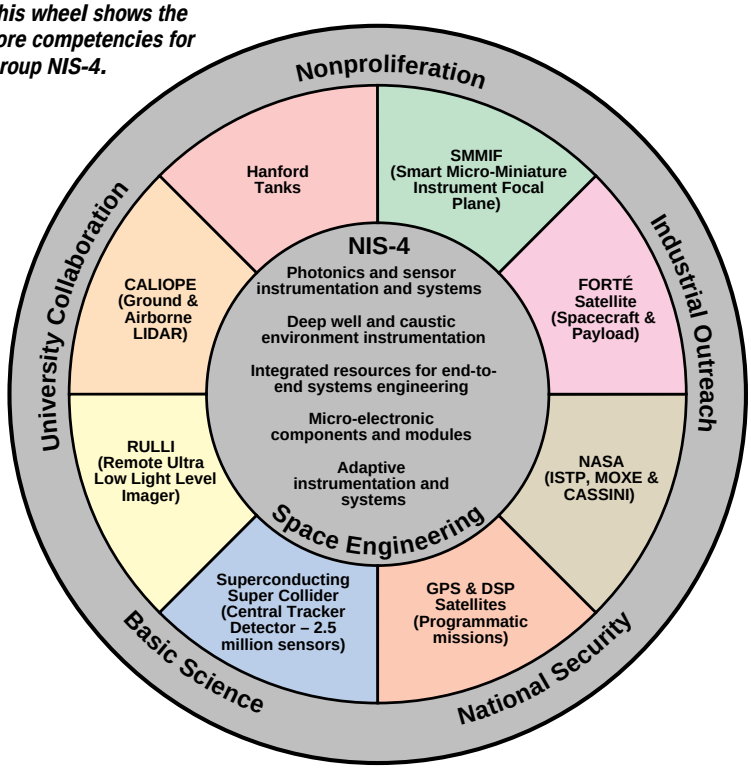
NIS-4 develops high-quality, reliable instruments and systems for unattended, stable, long-term, failure-free operation in high-radiation, high-temperature, high-pressure, or caustic-fluid environments such as deep wells. An integrated engineering approach permits close interactions among the scientists, the modeling and analysis personnel for sensor device physics, the photonics engineers associated with the optical data acquisition system, and the electronics and mechanical engineers. NIS-4 has developed more than 400 instruments and systems from design to completion with no significant failures.

Scientific support includes physicists developing models of sensors with analyses to assure performance within the measurement environment. The scientists work closely with the electronics and mechanical engineers in developing a project.

RN94 322 003

High-reliability assembly performed by highly skilled and trained technicians supports the division's mission.

This wheel shows the core competencies for Group NIS-4.



Electronics engineering includes the development of both analog and digital circuits employing state-of-the-art application-specific integrated circuits (ASICs) and micro-miniature packaging technology for best speed/noise performances and intelligent sensor development in radiation environments.

Mechanical engineering develops lightweight structures and systems for applications from deep space to deep within the earth's interior for survival under severe environmental conditions. All design packages include appropriate structural and thermal analysis and tests to validate designs and verify the integrity and survivability of the hardware. Engineering personnel have extensive experience in the development of systems that have applications to high-radiation, high-temperature, and high-pressure environments.

Technicians support all aspects of instrument and systems development: laboratory testing of concepts, design, fabrication, assembly, characterization and calibration, final acceptance tests, and on-orbit turn. Technical skills include electronics, optics, high-quality vacuum-deposited coatings, plastics and scintillating-material technology, and high-quality environmental coatings.

Safeguards Science and Technology (NIS-5)

Group Leader: Avigdor Gavron
Phone: 505-667-2448
Deputy Group Leader: Mark Pickrell

NIS-5 works to safeguard nuclear materials by developing techniques and systems for nondestructive assay (NDA) measurements on nuclear and hazardous materials. Development ranges from conceptual research, to engineering, to implementation, and to training. Technology development enhances nuclear materials control and accountability at domestic DOE nuclear facilities and supports international nonproliferation activities.

NIS-5 provides measurement, instrumentation, and analysis technology that allows the NDA of nuclear materials by detecting and analyzing the neutrons or gamma rays given off by the material. The analysis can be either active or passive. In active techniques, the nuclear material is bombarded with neutrons or gamma rays and the neutrons or gamma rays given off in response are detected. Some nuclear materials produce sufficient quantities of neutrons or gamma rays to make a detectable passive signature. Analysis of the energies and intensities of these neutrons and gamma rays reveals the identity and quantity of the nuclear material.

NIS-5 provides measurement, analysis, and NDA instrumentation for safeguards organizations within the U.S. and throughout the world. The following are some examples:

- DOE Office of Safeguards and Security (NDA technology for nuclear materials accountability and inventory verification in DOE facilities)
- DOE (Data Acquisition and Control System for Hanford tank mitigation)
- International Atomic Energy Agency (technology development and training)
- International nonproliferation technology (support for U.S. bilateral safeguards collaborations to support the application of inspection technology)
- Russia, Kazakhstan, and the Ukraine (lab-to-lab interactions and training)

Following are some of NIS-5's areas of expertise and some specific projects:

- NDA measurement technology using neutrons and gamma rays [shufflers, passive and active neutron counters, tomographic gamma scanners (with NIS-6)]
- Integrated NDA systems for control and accountability of nuclear materials
- Continuous/unattended monitoring systems and information management analysis
- NDA training on gamma-ray and neutron assay, holdup, and waste measurements
- Detectors and electronics development for portable measurements (miniature modular multichannel analyzer)
- Technology development for holdup, confirmatory measurements, and inventory verification (generalized geometry holdup technique)
- Experimental and computational physics and simulation for NDA technology (design of gamma-ray assay systems and neutron multiplicity counters)

RN91-027-006

An NIS-5 staff member (second from left) demonstrates the detection of nuclear material held up in a piece of equipment to students in a safeguards training course.

RN89 193 002

An NIS-5 staff member (center) trains students from Luxembourg (left) and the Peoples' Republic of China (right) to calibrate a neutron coincidence collar for measuring light-water reactor fuel.

Advanced Nuclear Technology (NIS-6)

Group Leader: Richard E. Anderson
Phone: 505-667-4839
Deputy Group Leader:
John C. Pratt

The Advanced Nuclear Technology group (NIS-6) uses a large array of radioactive nuclear materials to undertake projects in nuclear criticality research and training and to develop and validate nuclear radiation detection equipment. These primary endeavors, in turn, support basic research in nuclear chain-reacting systems along with programs in arms control and treaty verification, waste assay, safeguards and accountability, and environmental restoration. NIS-6's inventory of active nuclear materials ranges from small alpha-, beta-, gamma-, and neutron-emitting sources for use in radiation detector development and calibration to larger quantities of special nuclear materials, such as plutonium and uranium, which are used in criticality experiments.

CN92 1115

The Los Alamos Critical Experiments Facility burst reactor Godiva-IV, which is capable of an output of 5 x 10^{16} neutrons within a 0.05-ms-wide burst.

CN88-4486

A test of an instrument developed at NIS-6 to locate the nuclear materials present within a simulated missile.

The Los Alamos Critical Experiments Facility, which is operated by NIS-6, represents the largest collection of nuclear critical mass assembly machines in the Western Hemisphere. The facility includes the high-neutron-intensity burst assemblies Godiva-IV and Skua; the assembly machine Flattop, which is used in critical operations training; and the unique-solution critical assembly SHEBA (solution high-energy burst assembly). On other facility assembly machines, experimental configurations of various nuclear materials can be brought to a critical state for detailed testing of new concepts for nuclear materials behavior and for benchmarking computer models.

Research and development for radiation detection instruments touches on many programs of national interest, including the Nuclear Emergency Search Team (NEST). For the NEST program, NIS-6 has developed portable gamma-ray and neutron detectors that help assess potential threats from terrorists. NIS-6 trains NEST personnel in the use of these instruments.

For nuclear materials safeguards and accountability programs, NIS-6 has developed and built pedestrian and vehicle portal monitors and hand-held neutron and gamma-ray detectors. An enhanced method of assaying milligrams of fissile material contained in various matrices is being developed. This method uses neutrons from a 14-MeV neutron generator to interrogate objects using the combined thermal-epithermal neutron (CTEN) method.

NIS-6 also operates a simulation facility in which nuclear materials can be configured to resemble nuclear devices. These mockups can be used to develop and validate instruments and methods used in nuclear nonproliferation work.

A new method of monitoring alpha-particle-emitting nuclear materials is in rapid development at NIS-6. Long-range alpha detector (LRAD) technology includes monitoring personnel, equipment, soils, liquid and gaseous effluents, and radon. LRAD technology is flexible enough to be used in such diverse programs as arms control, safeguards, decontamination and decommissioning, and environmental remediation.

Safeguards Systems (NIS-7)

Group Leader: Richard Strittmatter
Phone: 505-667-7777
Deputy Group Leader: Joan Prommel

NIS-7, Safeguards Systems, engages in nonproliferation systems studies and policy analysis, develops information analysis algorithms and software, and develops information management systems. Core capabilities include knowledge of nuclear material process chemistry, facility operations, destructive and nondestructive measurement methods, simulation, modeling, data analysis (including statistics, machine learning, and anomaly detection), and software development using object-oriented approaches and client/server architectures.

Systems studies for nonproliferation analyze complex interactions between nuclear facility operations and verification technologies and procedures. The studies define technical and policy options for the implementation of nonproliferation regimes. Areas of development and capabilities demonstrated by systems studies include design and evaluation of domestic safeguards systems, design and evaluation of international verification systems, safeguards systems design optimization, policy development and analysis for DOE, facility simulation, signature/indicator analysis and evaluation of nuclear facilities, familiarity with all aspects of nuclear facility operations, security of safeguards information systems, and computer security.

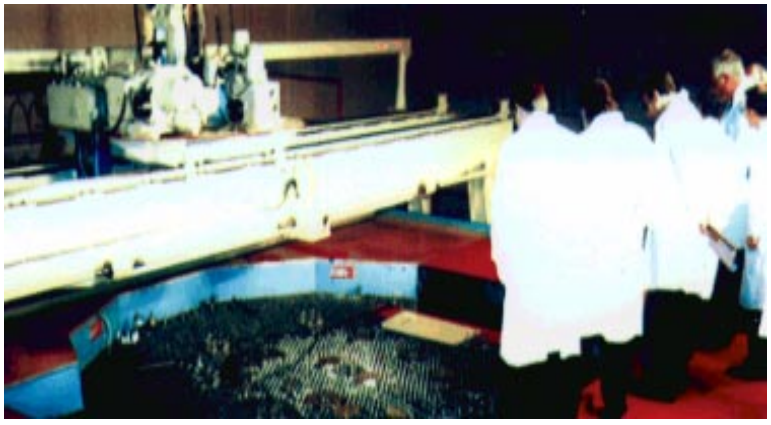
Information analysis covers a broad area of algorithm development: image processing software, data analysis, anomaly detection (identifying anomalies in safeguards information, satellite data, computer security audit data, review of video and sensor data, and fraud detection), risk analysis, and automatic database assessment (utilizing expert systems, neural networks, and statistical decision procedures).

The growing area of information management includes the development of nuclear material accounting software to help manage DOE's nuclear material (incorporating the technologies of relational database design and graphical user interfaces), the use of open source information, and the storage and retrieval of large quantities of safeguards-relevant text.

NIS-7 provides services to many organizations and countries throughout the world. The following are examples:

- DOE (nuclear materials control and accounting software, image processing software, and technical support to policy development in nonproliferation)
- International Atomic Energy Agency (reprocessing safeguards methods)
- National Security Agency (data analysis software)
- Japan (systems studies, simulations, and anomaly detection for mixed oxide fuel fabrication and reprocessing facilities)
- Russia, Kazakhstan, and the Ukraine (materials control and accounting support and training)
- South Korea (technical interactions in safeguards)

An automatic video surveillance system monitors storage facilities for unauthorized access. Zones of interest are indicated by colored lines. Alarm is given when motion is detected in red and yellow areas.

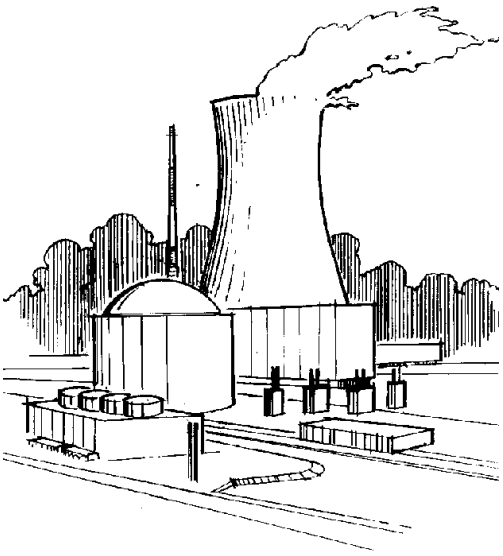


NIS-7 participated in a U.S./Russian Laboratory-to-Laboratory nuclear materials protection, control, and accounting program aimed at reducing the risk of nuclear weapons proliferation at facilities such as this critical assembly in Obninsk, Russia.

Nonproliferation & International Technology (NIS-8)

Group Leader: Ellen Leonard
Phone: 505-667-2938
Deputy Group Leader: Michael MacInnes

The Nonproliferation & International Technology group (NIS-8) studies international scientific research, development, and production related to the proliferation of weapons of mass destruction. NIS-8 works to deter the proliferation of nuclear materials, weapons of mass destruction, and critical technologies by applying scientific and engineering expertise and developing computerized information systems. NIS-8 maintains expertise in reactor and fuel cycle design, reactor safety systems design, information sciences, special nuclear materials production, nuclear weapon production, weapon testing, image enhancement and analysis, and foreign languages. Technical analyses support U.S. government concerns regarding foreign civil, military, and commercial technological advances.



NIS-8 evaluates nuclear facilities for the role they can play in a national nuclear program.

As the Laboratory's lead organization for support of export control activities in DOE's Office of Arms Control and Nonproliferation, Export Control Division, NIS-8 provides technical support to the Nuclear Suppliers Group and other national and international nuclear export control organizations. Activities include (1) determining commodities that should be controlled and assisting in obtaining national and international agreement for control, (2) supporting export license case reviews, and (3) providing education on nuclear technology and proliferation for government export control personnel.

93-21 23A

Hungarian export control authorities work with an NIS-8 designed and delivered Nuclear Suppliers Group Information Sharing System (NISS) workstation. The NISS prototype provides reference documents, electronic mail, and computer tools to help export licensing officers from various countries make decisions concerning the export of dual-use items that could be used in the research, design, testing, production, or use of nuclear weapons.

Other significant efforts include

- Developing the prototype Information Sharing System for the Nuclear Suppliers Group
- Helping other nations—principally the Newly Independent States of the former Soviet Union—establish and administer controls on the exports of nuclear weapon commodities, technologies, and expertise. This program trains graduate students to act as facilitators in the former Soviet Union
- Identifying collaborative scientific research and development opportunities with nations of the former Soviet Union
- Developing the national Proliferation Information Network System to aid in export license processing and communication between DOE headquarters, DOE laboratories, and other agencies concerned with export control and nonproliferation activities
- Analyzing technologies in U.S. weapon systems for a Department of Defense Technology Security Program to recommend security requirements before systems are transferred abroad

Weapon Design Technologies (NIS-9)

Group Leader: Rodney S. Thurston
Phone: 505-667-2832

Deputy Group Leader:
Michael P. Webb

NIS-9 applies science and technology available throughout LANL to support national agencies concerned with the proliferation of technologies that can be used to design weapons with very-large-scale effects. The effects can be produced with nuclear, biological, chemical, or information science. We support agencies with national security objectives for intelligence, defense, energy, and law enforcement. Tasking and funding from any agency must be approved by the DOE Office of Energy Intelligence.

In analyzing the threat posed by foreign weapons of mass destruction to the U.S. and its interests, NIS-9 uses its technical expertise in the review of intelligence data from any source on the extent, capabilities, physical assets, and modus operandi of foreign nuclear, chemical, and biological weapons programs.

With its extensive background in U.S. nuclear weapons design and foreign nuclear intelligence, NIS-9 contains much of LANL's corporate knowledge in areas related to foreign nuclear design technology. With consultants and other LANL organizations, NIS-9 assesses the technology and capability of potential nuclear proliferants, the nuclear performance of suspect designs, and national responses to nuclear terrorism.

NIS-9 also provides intelligence information to LANL managers and others.

Examples of topics analyzed by NIS-9 in support of the intelligence community are

- Foreign nuclear development programs
- Safety issues of foreign nuclear weapons
- Potential nuclear weapon capabilities of particular countries
- Items of interest to the Nuclear Emergency Search Team and other respondents to potential incidents
- Biological and chemical warfare
- Nuclear missile system defense

Information-science technology includes the security, vulnerability, and enhancement of information systems and infrastructure, information assurance, security of computer systems, remote measurements, and the evaluation and reverse engineering of nonstandard equipment.

A potential proliferant ballistic missile system capable of delivering nuclear, chemical, or biological warheads.

Remote measurement activities have included detecting and characterizing distant events and developing sensors for optical, RF, or audio spectrum measurements.

Security of computer systems has involved the application of research to solutions and policy development for protecting computer systems and networks, evaluating computer systems and networks, and training.

Some notable applications from information-science research are methods for long-term storage of data and data embedding. Both technologies have potential commercial applications as well as security applications, and both can be used in information assurance.

Facilities at TA-33. Text similar to this brochure is embedded in the white noise of the digital image. This is one example of the information technologies under development by NIS-9.

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Deputy Group Leader: Paul G. Weber
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NIS personnel participate in initial tests of a FORTÉ RF antenna of unique design.

RN95 381019

Discussions among NIS scientists continue after the annual Division meeting.

NIS-5 Safeguards Science and Technology

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Secretary Karen Trujillo, Phone: 505-667-7110

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Additional information on NIS Division is available via the World Wide Web using URL http://www.lanl.gov:8010/divisions/nis

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Secretary Sara Cochrane, Phone: 505-665-5312

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Secretary Margy G. Scales, Phone: 505-667-6722

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*Unclassified Mail Stop
**Classified Mail Stop